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The Effects of SIMNET Role-Playing on the Training of Prospective Platoon Leaders

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November 1991

United States Army Research Institute
for the Behavioral and Social Sciences

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This investigation examined the relative value of having prospective armor platoon leaders engage in role-playing activities while using the Simulation Networking (SIMNET) training simulator. Training records were examined for 470 students in Armor Officer Basic (AOB) classes from late 1988 to mid-1989. During the SIMNET training exercises, 123 (26.2%), 115 (24.5%), 194 (41.3%), and 38 (8.1%) of these students acted as platoon leader, platoon sergeant, tank commander, and driver/gunner/loader, respectively. Regression analyses were performed on the measures obtained from course records. The results demonstrate that being in a platoon leadership position during SIMNET training leads to the highest performance evaluations. These findings imply that AOB students should have direct experience in platoon leadership positions during their SIMNET training. (25)

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FOREWORD

The modern Army is faced with the challenge of providing quality training in tactical skills while using fewer instructional resources. To address the need to train using fewer resources, the Defense Advanced Research Projects Agency (DARPA) developed the technological base for large-scale interactive simulation that resulted in the Simulation Networking (SIMNET) system for the Army. The SIMNET system at Fort Knox provides a prototype test-bed that defines requirements for future ground-unit technical training devices. This research examined the instructional value of having students from the Armor Officer Basic (AOB) Course serve in a platoon leadership role during SIMNET training. Benefits of the SIMNET training were assessed by examining student leader performance in later platoon field exercises.

This research is part of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Fort Knox Field Unit's program on unit training strategies. One purpose of this research program is to examine training methods and strategies for networked simulators. This work was pursuant to a Letter of Agreement (LOA) between ARI, the U.S. Army Armor Center, the U.S. Army Materiel Command, and the U.S. Army Training and Doctrine Command, effective 16 January 1989. The LOA was titled "Effects of Simulators and Other Training Resources on Training Readiness." The Commanding General, U.S. Army Armor Center and Fort Knox, provided specific impetus for this research by asking ARI to assess the value of SIMNET for institutional training.

The research findings indicate that SIMNET practice in a platoon leadership role was more beneficial than participation in other positions in the platoon. Evidence was also obtained to show that the benefits of SIMNET training increased as the AOB instructors gained experience using SIMNET. These results will be of interest to Army trainers responsible for leader training and unit collective training. The results are important also to those involved in design, development, and testing of unit training devices.

EDGAR M. JOHNSON
Technical Director

THE EFFECTS OF SIMNET ROLE-PLAYING ON THE TRAINING OF PROSPECTIVE PLATOON LEADERS

EXECUTIVE SUMMARY

Requirement:

Due to budgetary constraints, a major challenge to the modern Army is to provide effective training using fewer resources. Training officers and units in tactical skills in a field environment has become increasingly expensive. To address the need for less costly training, the Defense Advanced Research Projects Agency (DARPA) investigated computer technologies to support large-scale simulation of ground combat. The Army has adopted the resulting Simulation Networking (SIMNET) system as a prototype test-bed to help define its requirements for collective unit training devices. At Fort Knox, the U.S. Army Armor School has used SIMNET to train prospective platoon leaders in the Armor Officer Basic (AOB) Course. A possible restriction on SIMNET's effectiveness for AOB students is that only a limited number of students can serve in platoon leadership roles during the available training period. This research project examined the instructional value of having AOB students serve in platoon leadership roles during SIMNET training.

Procedure:

This research examined training records for 470 students in AOB classes from late 1988 to mid-1989. These records were the Field Evaluation-Armor Platoon Tactics (ATSB-CS Form 1447) and SIMNET Training Reports (STTRs). During the SIMNET training exercises, 123 (26.2%), 115 (24.5%), 194 (41.3%), and 38 (1.8%) of these students attained the roles of platoon leader, platoon sergeant, tank commander, and driver/gunner/loader, respectively. Performance measures consisted of the students' scores on two evaluations using Form 1447. If a student was a platoon leader for his first field evaluation, then he was a platoon sergeant for his second field evaluation and vice-versa.

Regression analyses were computed to determine the impact of serving in SIMNET leadership positions on the students' field measures. Separate analyses were conducted for first and second field ratings. Predictor variables for the regression equations were as follows: (a) three dummy-coded categories representing the students' roles on SIMNET, (b) quadratic polynomial functions across the days of field training (day variable), (c) differences across the different weeks (and classes) of AOB training (weeks

variable), and (d) a dummy-coded category for the sequence of field leadership positions. Differences in the students' field performance scores arising from the rating biases of the instructors who evaluated them were partialed out in both regression analyses. Also, the regression analysis on the second set of field ratings included the scores on the first set of ratings as a covariate variable.

Findings:

The results demonstrated that being in a platoon leadership position (either as a platoon leader or platoon sergeant) during SIMNET training led to higher performance evaluations when students were platoon leaders in the later field exercises. No similar increase in field evaluations was found for students acting as platoon sergeants, since SIMNET did not provide much opportunity to practice platoon sergeant duties. The results also indicated that the benefits of SIMNET gradually increased as the AOB instructors gained experience in using this training technology. This increase may be associated with improvements in the after-action reviews (AARs) conducted by the instructors as the total weeks of SIMNET use in AOB increased along with the cumulative number of classes trained in SIMNET.

These findings imply that AOB students should have some direct experience in platoon leadership positions during their SIMNET training. Also, the lessons learned by AOB instructors while using SIMNET should be transferred from one generation of AOB instructors to the next. Similar guidance is likely to be valid for other training applications of networked simulations.

Utilization of Findings:

Results of this research were briefed to U.S. Army Armor School departments using SIMNET for training in school courses. The report has been provided to agencies responsible for Armor training device requirements and development and also to those involved in developing collective training doctrine and plans for Armor units.

THE EFFECTS OF SIMNET ROLE-PLAYING ON THE TRAINING OF PROSPECTIVE PLATOON LEADERS

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THE EFFECTS OF SIMNET ROLE-PLAYING ON THE TRAINING OF PROSPECTIVE PLATOON LEADERS

Introduction

Due to budgetary constraints, a major challenge to the modern Army is to provide more effective training while using fewer resources. Training officers and units in tactical skills in a field environment has become increasingly expensive. For example, the cost of operating and maintaining a tank in the field has been estimated to be nearly $550 per hour (M. Kelly, personal communication, 31 January 1990). As resources diminish, the limited amount of field training that can be provided may fall short of that needed to maintain skills at required levels. Nevertheless, few effective alternatives have been developed to complement field training. Relatively inexpensive table-top exercises and board games can have considerable value for initial training (Bessemer, 1985), but they are not able to faithfully reproduce important conditions inherent in field exercises (Kristiansen, 1987). Computer-based instruction has proved to have limited usefulness for tactical training (e.g., see Morrison, Drucker, Kern, & Foster, 1989). After examining tactical training methods then in common use, Henricksen, Jones, Sergeant, and Rutherford (1984) concluded that low-cost training devices and computer simulations were not available to support tactical training, and the potential applications of several rapidly advancing technologies remained to be explored.

To address needs for more affordable collective training, the Defense Advanced Research Projects Agency (DARPA) developed and investigated computer technologies needed to support large-scale simulation of ground combat. The Army has adopted the resulting Simulation Networking (SIMNET) system as a prototype test bed to help define its requirements for collective unit training devices. SIMNET has thus become a focal point of attention within the Army training community (Atwood & Doherty, 1989). To gain experience with the capabilities of the system, exercises in SIMNET have been used to train units from platoon to brigade levels. SIMNET also has been used by the U.S. Army Armor School at Fort Knox as an integral part of the Armor Officer Basic (AOB) Course. This course trains inexperienced lieutenants to be platoon leaders.

SIMNET training in the AOB class occurs after students complete their classroom training and before they engage in field exercises. Exercises in SIMNET give AOB students their first opportunity to perform in a real-time interactive environment the basic tactical techniques previously taught in the classroom. SIMNET exercises allow the students to execute platoon missions similar to types of missions practiced in the field, but in less demanding and stressful conditions. Both the SIMNET training and later field training are designed to help AOB students become proficient in many skills that platoon leaders must exhibit when commanding a platoon in battle. After graduation from this course and assignment to an active Army unit, these students are expected to show competence with:

1. Analyzing the mission.
2. Issuing a warning order.
3. Completing the plan.
4. Preparing an operations order.
5. Issuing the operations order.
6. Supervising unit mission preparations.
7. Controlling platoon fire and movement.
8. Clearing and securing an objective.
9. Directing occupation of a battle position.
10. Conducting the defense of a battle position.
11. Calling and adjusting indirect fires.
12. Reporting all movements and actions to the company commander.

Overview of SIMNET

Although SIMNET has continued to evolve, the general description provided below characterizes SIMNET when this investigation took place. SIMNET is a high technology simulated battlefield consisting of combat vehicle simulators and combat support equipment. The Combined Arms Tactical Training Center (CATTC, formerly known as the SIMNET Warfighting Complex) at Fort Knox consists of: (a) simulated M1 Abrams tanks and M2/3 Bradley infantry/cavalry fighting vehicles, (b) simulated close air support (CAS) aircraft, (c) Tactical Operations Center (TOC), and (d) an Administrative/Logistic Center (Thorpe, 1988). With this equipment, Army trainers can perform battalion task force operations, company team operations, or platoon operations.

Each vehicle simulator is a separate module with space for all crew positions. The vehicles operate in a closed-hatch mode on a battlefield created by computers. Selected weapons systems are available on each simulator (e.g., main gun for the M1 tank) along with the required displays, switches, and controls.

Each crew station has a slightly different view of the battlefield terrain. The SIMNET M1's visual system, for example, provides eight independent visual channels of the battlefield terrain which are displayed in vision blocks and sights at the four crew positions (Dubois & Smith, 1989). These computer-generated graphics provide crew members real-time (15 hz) updates of natural terrain features and many cultural features within a 3,500 meter radius (Cyrus, 1987). Very small scale features are omitted, so the terrain is rather smooth relative to the real world. The crew members hear computer-generated sounds that help to create the illusion of operating actual vehicles over real terrain. Also, the simulators operate under constraints similar to those affecting actual vehicles. For example, fuel consumption for the M1 simulators approaches the consumption rates predicted for an M1 tank under actual combat conditions.

SIMNET's fidelity is further described by the following passage in the SIMNET M-1 Crew Manual (Perceptronics, 1987):

> The SIMNET M1 and its crew live in a world created by a computer. In this world, you will find hills, trees, buildings, roads, streams, power lines, tanks, APCs, trucks, howitzers, mortars, command posts, etc. You will also find other crews in their combat vehicles, both friendly and enemy. You will interact with them just like the M1 tank and its crew does in the real world. For example, if you ram a big tree with your gun tube you may break the turret traversing gear. (p. 1)

SIMNET has some additional features that were designed to support training. Semi-automated forces (SAFOR) are available to simulate either friendly or hostile combat elements. Opposing forces can thus be played either by the SAFOR or by personnel manning simulators in force-on-force battles. A plan view display (PVD) and stealth vehicle are available to support observation of SIMNET exercises. The PVD provides a graphic map display of portions of the battleground with icons representing vehicles. The stealth capability provides a direct view of the battleground from an invisible vehicle moving on or above the terrain. A data logger can record SIMNET exercises for replay through the PVD and stealth vehicle to support after action reviews (AARs). Further descriptions of SIMNET can be found in the operator's guide (U.S. Army Armor School, 1987), the user's guide (U.S. Army Armor School, 1989), and the crew manual (Perceptronics, 1987).

Four previous studies have investigated SIMNET's effectiveness as a training device (Bessemer, 1991; Brown, Pishel, & Southard, 1988; Kraemer & Bessemer, 1987; TEXCOM, 1990). Kraemer & Bessemer found that SIMNET training improved fire-control skills for several highly experienced armor platoons who were practicing for the Canadian Armor Trophy competition. Brown et al. (also reported by Thorpe, 1988) found more noticeable improvement for a SIMNET trained group than for a field trained group in executing proper platoon formations.

There were several limitations on the results of the Brown et al. (1988) and Kraemer and Bessemer (1987) studies. For one thing, both studies examined SIMNET's effectiveness for a small number of experienced troops across one training period. Secondly, the effectiveness of SIMNET training was based on observational data. Thirdly, these two studies did not specifically focus upon the performance of the platoon leaders as neither study used criterion measures which directly reflect the performance of the platoon leaders (Bessemer, 1991). Improvements found in the platoon's gunnery skills, for example, might not have indicated learning by the platoon leader.

TEXCOM (1990) observers rated pass/fail performance of platoon tasks and task standards in a field exercise given as a pretest and posttest with five days of intervening SIMNET training. Nine tank platoons and nine mechanized infantry platoons received SIMNET training, but no additional platoons were tested as controls without SIMNET training. Significant gains from pretest to posttest exercises were found for both types of platoons. Since the platoons may have learned from the pretest as well as SIMNET exercises, the interpretation of the gains is ambiguous. Without control groups, the portion of the gain resulting from SIMNET training is uncertain. Like earlier studies of SIMNET training effects, this experiment did not examine the platoon leader's contribution to the observed gains.

Bessemer (1991) conducted a quasi-experimental investigation of SIMNET's effectiveness for training AOB students. This study concentrated on examining the performance of student platoon leaders and platoon sergeants rather than platoon performance. Records of the tactical field exercises were examined for AOB classes from mid-1987 to mid-1989. These records provided AOB instructor's ratings of the students' performance when acting as platoon leader or platoon sergeant. Since SIMNET training was incorporated into the AOB course in December, 1988, those classes completed before this change represented the baseline condition while those occurring after the change represented the treatment condition in an interrupted time-series design (Cook & Campbell, 1979). This sample consisted of 1705 AOB students of which 646 received SIMNET training and 1059 did not.

SIMNET training was found to have a positive impact upon the instructors' ratings of performance during field exercises. SIMNET was also shown to help the students to receive additional field training on more advanced exercises. Therefore, SIMNET seemed to be useful for training inexperienced officers to become platoon leaders. SIMNET's usefulness, however, was found to increase as the AOB instructors gained experience with using this training technology. Instructors that have limited experience may thus limit SIMNET's effectiveness for training AOB students.

Another possible limitation of SIMNET training for AOB students is that only a few students can serve in platoon leadership roles per exercise. Each AOB class usually consists of three or four platoons with each platoon consisting of approximately 16 students. Since only two students per platoon can serve as either a platoon leader or sergeant for each exercise, a sizeable number of these students will not have the opportunity to directly practice their platoon leadership skills in SIMNET. Its effectiveness as a training simulator for the AOB course may then be limited to those few prospective platoon leaders who are able to practice their platoon leadership skills.

Practice and Learning

The need for active practice by the learner is a cherished belief in instructional psychology. This belief has been held by psychologists with completely different orientations (e.g., Dewey, 1938, 1956; Thorndike, 1899). Thorndike postulated a law of exercise in which the more an S-R connection was practiced the stronger it became. Dewey argued that learning environments must provide the learner with opportunities to learn by doing.

Having students engage in active practice has been an important component of military training. The Interservice Procedures for Instructional Systems Development (U.S. Army Training and Doctrine Command, 1975) recommended that students be given the opportunity to directly perform the task to be learned. As stated in the cited document:

> The second general learning guideline (for military training) is active responses on the part of the student. Students learn better when they actively practice the new learning. Practice on performance can assist in learning faster, improving during learning, and retaining what is learned. (vol. 3, p. 4)

However, the evidence available to substantiate such generalized claims about the instructional value of active practice was not cited or discussed.

Psychologists have recently become interested in reexamining the relationship between active practice and learning (Baggett, 1987, 1988; Hannafin, Phillips & Tripp, 1986; Shyu, Garry, Kim, & Brown, 1990; Spurlin, Dansereau, Larson, & Brooks, 1984; Swezey, Llaneras, Allen, & Perez, 1989). Spurlin et al., for example, found that active learning was a key variable in students' ability to recall textual information. Dyadic pairs who actively discussed the textual materials recalled more information than those pairs who did not.

Active learning has also been shown to be an important ingredient in procedural training (Shyu, Garry, Kim, & Brown, 1990; Spurlin, Dansereau, Larson, & Brooks, 1984; Swezey, Llaneras, Allen, & Perez, 1989). Shyu et al., for example, examined the effects of practice upon college students' abilities to construct an Origami crane from memory. Instructions for this task were either provided by a manual with text and diagram instructions or by interactive videodisc instructions. Each instructional group was split into a practice and nonpractice group. The nonpractice group watched a videodisc presentation of a person completing the task. This study also included a control group in which students were to teach the tasks to themselves. Active practice was shown to have a positive impact upon the students' performance. No differences were found in the students' performance associated with the different instructional media. Swezey et al., (1989) also found that hands-on practice was more important than the mode of instruction (computer-based instruction delivery versus videotaped lecture delivery) for training maintenance technicians to do a moderately complex procedural task.

Active practice has furthermore been hypothesized to be a key instructional variable in cognitive training (Reigeluth & Schwartz, 1989). Reigeluth & Schwartz have claimed that teaching cognitive skills involves two distinct learning phases. The first phase is the acquisition phase in which the students obtain a basic knowledge of the instructional content. They can complete this phase through passive interactions with the environment such as listening to a lecture or by observing examples provided by a simulator. During the second phase--the application phase--the student learns to apply the principles associated with the content to a particular situation. Active practice in the form of role-playing is needed to complete the application phase as such practice provides the students with the experience needed to understand the underlying principles.

Reigeluth and Schwartz (1989) have also claimed that simulators are a most effective training medium for providing realistic role-playing experiences. As they have stated:

> Simulations are often the only means of instruction in which the learner can actually perform the procedure or apply the principle under realistic conditions. (p. 9)

This view on simulators and role-playing experiences has been shared by other professionals in this field (e.g, Flaxman & Stark, 1987; Hays & Singer, 1988; and McPhail, 1972). As noted by McPhail (1972), role-playing has the great advantage of allowing the students to exercise the skills and abilities employed in real life situations without the fear of making any irrevocable mistakes, e.g., damaging a tank.

The AOB class is structured in a manner similar to the instructional model proposed by Reigeluth & Schwartz (1989). SIMNET practice occurs in the AOB class after the students initially acquire some basic tactical knowledge through class lectures and readings. According to the instructional model of Reigeluth & Schwartz, SIMNET practice should have helped the prospective platoon leaders to develop the cognitive skills necessary for understanding and using the principles of tactics in a battlefield situation.

Helping the platoon leader to develop cognitive skills through role-playing experiences is important for a number of other reasons. First, Clark and Voogel (1986) have argued that understanding concepts and principles is important because it helps the learner to transfer the knowledge to unique situations. A platoon leader who understands the principles of tactics can then apply his knowledge to situations which have not previously been presented in the AOB Course. Second, Halff, Hollan, and Hutchins (1986) have suggested that being a competent platoon leader requires the cognitive facility to make quick decisions about the enemy's position, to develop a strategy for dealing with this threat, and to coordinate this strategy with other platoons in the company. Finally, cognitive training would also help the prospective platoon leader in developing the ability to appropriately find and employ information from memory, which is the key to expert thinking (Tennyson & Rasch, 1988).

Correspondingly then, practice on SIMNET in the form of role-playing by AOB students could play a crucial role in their development as platoon leaders. However, there is very little empirical evidence regarding the relationship between practice and cognitive training. Reigeluth and Schwartz (1989), for example, did not provide any data to support their previously discussed model of instructional design. Also, an extensive literature search utilizing the Defense Technical Information Center (DTIC), Educational Resources Information Clearinghouse (ERIC), and the Social Science Index data bases failed to provide any empirical data on this topic. This search also included telephone interviews with some of the leading experts in the field of cognitive training (e.g., Charles Reigeluth, Robert Hays, David Salisbury, and Robert Swezey)

Furthermore, there are few studies that provide empirical data on cognitive training using simulators (e.g., Hays & Singer, 1988). These works, while citing the importance of practice, have focused upon either examining the simulator's validity or the human-computer variables associated with developing the simulator (Criswell, Unger, Swezey, & Streufert, 1983; Swezey, Streufert, Criswell, Unger, & Van Rijn, 1984; Swezey, 1984). Swezey and his associates have developed and tested a computer simulator for teaching decision-making skills. This simulator was used to investigate issues of cognitive complexity rather than to explore relationships between practice and cognitive learning. The proper role of practice in cognitive training remains an empirical question.

Purpose

This research project examined the instructional value of having AOB students serve in a platoon leadership role during SIMNET training. Role-playing should make SIMNET training more effective. If this thesis is correct then every AOB student should be provided with the opportunity to be either a platoon leader or platoon sergeant during SIMNET training. Empirical support also would be provided for the belief that active practice is an important instructional variable for training cognitive tasks.

A secondary purpose was to determine the relationship between the students' week of AOB graduation and their field performance for students with SIMNET practice in different platoon roles. Bessemer's (1991) findings indicated that students in later SIMNET classes had higher field evaluations than those in earlier classes. Since the AOB instructors' collective experience increased as SIMNET training was repeated in successive AOB classes, Bessemer (1991) argued that an important predictor of SIMNET's effectiveness was the instructors' experience with this training device. However, if the increases in performance over time are found to vary between students with different roles in SIMNET, the nature of this effect could provide some basis for hypotheses about how the instructors' experience level influenced the student's transfer from SIMNET practice to field performance. Such differences can be related to differences in student-instructor contact for the various SIMNET roles. In particular, if the increase observed in later classes was larger for students that were platoon leaders or sergeants in SIMNET, this finding would tend to implicate as a source of the increase those communications that occur between instructors and students in leadership roles during an exercise.

Method

Data Source

This research examined training records for students in AOB classes from late-1988 to mid-1989. These records were the FIELD EVALUATION-ARMOR PLATOON TACTICS (ATSB-CS Form 1447), SIMNET TRAINING REPORTS (STTRs), and COMPREHENSIVE STUDENT EVALUATION - AOB TACTICS PHASE (ATSB-CS Form 1445).

Form 1447 is a standardized form used by the instructors during field exercises to grade the tactical performance of AOB students acting in leadership positions. During the course of the field exercises each student is evaluated twice on Form 1447, usually once as a platoon leader and once as a platoon sergeant.

The STTR, a form created by the Army Research Institute (ARI), was designed to obtain information on each student's role during SIMNET training. A student could be a platoon leader, platoon sergeant, tank commander, gunner, loader, or driver during a SIMNET exercise. The AOB instructors began completing these forms approximately three months after SIMNET was incorporated into the AOB course.

Personal data on the students were obtained from their Form 1445 records. The students complete items on this form regarding their: (a) citizenship, (b) source of commission, and (c) prior service. As done by Bessemer (1991), responses to these items were used to examine the similarity of the students sampled in the different treatment conditions.

Sample

Ten AOB classes with 470 students that received SIMNET training were included in the sample for this study. These classes included 22 students that were evaluated twice as a platoon leader or twice as a platoon sergeant, and were omitted from the sample. Eleven different officers and senior NCOs served as the primary instructors (titled "team chiefs") for these classes with one team chief per platoon. The ten AOB classes consisted of 32 platoons, approximately three per class.

In SIMNET training 123 (26.2%), 115 (24.5%), 194 (41.3%), and 38(8.1%) of these students attained the roles of platoon leader, platoon sergeant, tank commander, or other crewman (driver, gunner, or loader), respectively. This classification was based on the highest position occupied by a student during the SIMNET exercises. A student serving as platoon leader or platoon sergeant, for example, may also have been a tank commander or any other crew position in the other exercises. Students were assigned by their team chief to the roles of platoon leader, platoon sergeant, or tank commander. The team chiefs' assignments were random, except for the restriction that a student could not be a platoon leader or platoon sergeant for more than one exercise. Assignments to other crew positions were made by the student platoon leaders, platoon sergeants, and tank commanders.

As shown in Table 1, the group composition was similar for students in each SIMNET role except for the citizenship variable. Relative to U.S. citizens, foreign soldiers usually were not assigned to platoon leadership roles. Log-linear analysis (Bishop, Fienberg, & Holland, 1975) indicated a significant difference between distributions, with the test for independence between categories of citizenship and SIMNET roles producing a likelihood ratio $\chi^2(3, \underline{N} = 468) = 21.03$, $\underline{p} = .000$. However, foreign students were only 3.0% of this sample, so the unequal distributions do not seriously jeopardize this study's internal validity. Two students (0.04%) did not respond to this item.

For prior service, 149 students (31.7%) did not respond. Many of these students may have intended their nonreponse to be an indication of no prior service. However, the distributions of students that did respond and those with missing responses were not significantly different with $\alpha = .05$ (used for this and later tests in this section). The likelihood ratio test statistic for independence was $\chi^2(3, \underline{N} = 470) = 7.31$, $\underline{p} = .063$. Omitting the missing cases, the hypothesis of independence between prior service categories and SIMNET roles also was not rejected. In this case, the likelihood ratio test statistic was $\chi^2(9, \underline{N} = 321) = 11.36$, $\underline{p} = .252$.

For source of commission, only nine students (0.19%) failed to respond. These were distributed close to expectations, and the comparison between the distributions of nonresponding and the remaining students resulted in a nonsignificant likelihood ratio $\chi^2(3, \underline{N} = 470) = 3.80$, $\underline{p} = .283$. Omitting cases with missing data, the distributions of commission sources were statistically independent of SIMNET roles. The likelihood ratio test statistic was $\chi^2(9, \underline{N} = 461) = 14.03$, $\underline{p} = .121$, and the independence hypothesis was not rejected.

These results indicate that the personal characteristics of students found in groups with different roles in SIMNET training are generally representative of the total sample. With the single exception noted, observed variations in the frequency

Table 1

Characteristics of AOB Student Groups in Different SIMNET Roles

	Highest Position in SIMNET Exercises			
Category	Platoon Leader	Platoon Sergeant	Tank Commander	Other Crewman
		Citizenship		
USA[1]	122	114	186	32
Foreign	0	1	7	6
Missing	1	0	1	0
		Prior Service		
None	39	39	51	12
Active	9	9	11	7
Reserve	18	8	20	4
Undefined[2]	29	20	41	4
Missing	28	39	71	11
		Source of Commission		
Academy[3]	4	1	4	3
ROTC[4]	93	101	158	26
OCS[5]	24	11	22	6
Other[6]	1	1	5	1
Missing	1	1	5	2

[1]United States of America. [2]Response indicated some prior service, but type was omitted or ambiguous. [3]Graduates of U.S. military colleges are included. [4]Reserve Officer Training Corps. [5] Officer Candidate School. [6]Response was unclear or ambiguous.

distributions between groups could be attributed to chance, rather than to the operation of some systematic selection factors. Therefore, selection factors are unlikely to introduce serious biases into comparisons between the SIMNET role groups. Expected frequencies and residuals from the log-linear analyses are provided in Appendix A.

Training Procedure

SIMNET Training. The AOB classes received two days of SIMNET training. The first two hours of day 1 were spent in becoming familiar with the SIMNET equipment. This introduction included: (a) showing the students a **seven-minute** film on SIMNET, (b) briefing by the assistant instructors on the simulator's controls, and (c) allowing the students time to freely operate the simulated tank while practicing crew procedures.

After the time period for familiarization, the students were set for their first exercise--a tactical road march. The tactical road march consisted of platoons marching on the same route at staggered intervals of five minutes. During the road march, the platoons were to: (a) move in column formation, (b) perform a unscheduled halt when required, (c) react to an air attack, (d) conduct a contact drill, and (e) occupy an assembly area (AA). The road march usually lasted three hours with one and a half hours being spent in planning the operation based on the company operations order (OPORD) given by the platoon's team chief. An hour was spent in conducting the road march. During the exercise, the team chief stayed in radio contact with the platoon as he acted as the company commander to issue orders and receive reports. After completing the road march, the platoon spent about thirty minutes in an AAR led by the team chief. Following the review of the road march, the remainder of day 1 was used either to complete another road march or to practice different platoon formations and techniques of movement.

Day 2 was spent in conducting two force-on-force exercises with one platoon on offense and the other on defense. After one exercise, the platoons reversed sides for the second exercise. For offensive missions, a platoon was required to: (a) conduct a movement to contact, (b) react to enemy contact, and (c) conduct a hasty attack. The defensive missions required the platoon to: (a) occupy a battle position, (b) react to enemy contact, (c) defend a battle position, and (d) displace to a subsequent battle position. Each exercise took approximately three hours to complete with two hours being spent in planning and preparing the operation. The company OPORD was given to the platoon leader and platoon sergeant by the team chief. The platoon leader and sergeant then planned their operation and conducted troop-leading procedures. Thirty to forty-five minutes were used to complete the exercise, with the team chief for each platoon acting as its company commander. Afterward, the students spent thirty minutes in a joint AAR led by the team chiefs of the opposing platoons.

AARs were conducted as outlined in the Mission Training Plan (MTP) for the tank platoon (U.S. Department of the Army, 1988). The student platoon leaders used sketch maps on easel pads to describe their plans and the execution of the mission from their point of view. The team chiefs for both platoons then usually questioned the platoon leaders, platoon sergeants, and other students that were in favorable locations to observe events (a) to draw out information about key events that were important in determining the success or failure of the mission, and (b) to formulate alternative actions that might be more effective under the circumstances.

<u>Field Training</u>. After the SIMNET portion of AOB, the students then completed a 10-day field training period with the

students continuously staying in the field. Team chiefs and assistant team chiefs acted as the platoon's company commander throughout their field training. The early field exercises were similar to the SIMNET exercises with the addition of real tanks and terrain. These exercises included road marches, movement-to-contact, basic offense operations, and basic defense operations. Some road marches were conducted as logistical exercises that included refueling, rearming, and quartering party activities in assembly areas. The movement-to-contact missions provided cross-country practice on platoon formations and movement techniques. The initial offensive missions involved hasty attacks with consolidation and reorganization on the objective. Initial defensive missions required occupation and defense of a battle position. Smoke grenades of various colors simulated enemy fire.

After approximately five days of training, more advanced offensive and defensive missions were executed. These missions required the platoons to engage in simulated combat against each other or against a small, specially-trained opposing force unit. On the last two or three days of training, platoons were combined for a few company-level missions. These later offensive and defensive missions required the use of Multiple Integrated Laser Engagement Simulation (MILES) devices, which indicated the damage done to tanks on both sides by the opponent's fire. Smoke grenades were also used to simulate indirect fire requested by either the platoon or the enemy.

The sequence of events for each mission was similar to the sequence followed in SIMNET. The company OPORD was given to the platoon leader and platoon sergeant by the team chief. About two hours were spent in planning and preparing the mission. With actual tanks available, the student acting as a platoon sergeant spent more of his time supervising pre-operations maintenance, rather than assisting the student platoon leader in planning the operation. After the platoon leader gave his orders to the platoon sergeant and tank commanders, the mission was executed and then followed by an AAR. These AARS were conducted much like those for the SIMNET exercises. Sites equipped with bleachers, a sandtable, and tank models were available to support AARs in the AOB field training areas.

For the field exercises the students' crew positions were rotated frequently, with different individuals selected to serve as platoon leader, platoon sergeant, and TCs after each exercise. The students were cycled through these different crew positions twice or three times during these exercises. To the extent practicable, the students received similar amounts of training in each of their roles.

During these exercises, the TCIs (tank crew instructors) rode on special chairs mounted on the turret of each tank. These chairs enabled the TCIs to ride with and observe the crew. The team chiefs and assistant team chiefs followed the action in High Mobility Multi-Purpose Wheeled Vehicles (HMMWVs). These HMMWVs were equipped with radios set to two different frequencies. The team chiefs used one frequency to communicate directly with the TCIs while using the second one to communicate with the platoon.

Observations of Training

Two ARI staff members observed the SIMNET training for each class. Each staff member stayed with one platoon for an exercise and then rotated to another platoon for the next exercise. Most platoons were thus observed two or three times during their SIMNET training period. Notes were taken on significant events that occurred during these exercises.

As unobtrusively as possible, the interactions between the team chiefs and the student leaders were observed from the time the operations order was given to the end of the AARs. Before an exercise the ARI observer watched the platoon leader and platoon sergeant planning and giving the platoon OPORD. During an exercise observations were done either by listening to the radio communications between the team chief and platoon leader and by watching platoon actions on the PVD and stealth display, or by listening to the platoon net and observing from the loader's periscope while traveling with the team chief as he followed and observed the platoon in a SIMNET command tank. After the exercise during the AAR, the observer watched from one side of the student group where he could see the presentations of the platoon leaders and team chief comments using the easel, and the reactions of group members. The observers also informally talked to several of these students after their SIMNET training was completed. Students were told that the observers were interested in how the instructors used SIMNET for training, and that the students were not being evaluated by the observers.

The available ARI resources did not permit extended observations of the field exercises. The ARI staff members did observe one day of training for single platoons in two different classes for several offensive and defensive missions. These observations allowed the ARI staff to become familiar with training and evaluation procedures used in the field exercises.

Measures and Scoring Procedures

As indicated, the performance measures used for this study consisted of students' scores in two field exercises derived from instructor evaluations on Form 1447. With few exceptions, if a student was a platoon leader for the first evaluation then he was a platoon sergeant for the second evaluation, and vice-versa. Scores were based on 17 items (see Bessemer, 1991, Appendix C) that dealt with the following aspects of tactics: (a) planning and preparing the operation, (b) controlling and commanding the platoon during the operation, and (c) conducting the operation. The evaluations for the platoon leaders and platoon sergeants were originated by their TCIs. The team chief, who reviewed and sometimes modified the TCI's evaluations, signed the forms to record his final approval. Notations on the form identified the student and the position occupied during the exercise together with the date, time, and type of mission.

Each item was rated in categories labeled as outstanding, average, or unsatisfactory. There was also a non-applicable (N/A) category for each item if a rating was inappropriate for that item. Occasional unmarked items were included in the N/A category. Student scores for two field evaluations were derived by assigning numeric values of +1, 0, and -1 for an outstanding rating, average rating, or below average rating, respectively, to each item. The N/A items were not given a numeric value. For each evaluation, the total of the numeric values was divided by the number of rated items, omitting the N/A items. This average value was then multiplied by 100, which resulted in scores ranging from 100 to -100 with zero as the midpoint.

A strong central tendency bias was found for these evaluations with approximately twenty percent of the items rated as either outstanding or below average. This central tendency bias reduced the possibility of finding any transfer effects by restricting the variability within the sample.

Data Analyses

Regression analyses using SPSS^x, subprogram Regression (SPSS, 1986), were computed to determine the effects of role-playing in SIMNET leadership positions on the students' subsequent field evaluations. These analyses were designed to statistically remove extraneous variance associated with several variables from the comparisons of primary interest. Hence, reported means for the students' field ratings were adjusted for the effects of controlled and other independent variables. To compare adjusted mean performance between the different SIMNET training conditions, standard errors were derived from the regression results and used to compute pairwise t-tests. The α level for the different analyses and tests was set at .05.

Separate regression analyses were conducted for first and second field ratings. These analyses used individual students as the sampling unit. Two independent variables representing training conditions in the analyses had dummy coded categories indicating the students' highest level role on SIMNET. Two roles (platoon leader or sergeant, and tank commander) were coded with a 1 equaling membership in that category and 0 equaling non-membership. For instance, a student who became a platoon leader (or platoon sergeant) in any exercise was coded as 1 for the platoon leader or sergeant variable and 0 for the tank commander variable. Those who served only in other crewman positions (gunner, loader, or driver) were coded with 0 for both variables, representing a control condition for the training effects. A third training variable represented the difference between SIMNET platoon leaders and platoon sergeants, with these roles coded .5 and -.5 respectively, and a code of 0 was assigned to all others.

A fourth dummy coded training variable was the sequence of the students' evaluated leadership positions (position sequence). In the field exercises, the two sequences of evaluated positions were: (a) acting as platoon leader for Rating 1 and then as platoon sergeant for Rating 2 (coded by .5), or (b) acting as platoon sergeant and then as platoon leader (coded by -.5). The field position sequence variable thus compares the platoon leader group to the platoon sergeant group for Rating 1, and compares the same two groups of students with positions reversed for Rating 2. The 22 cases that did not fit either sequence (i.e., students that were evaluated twice in one position) were discarded from the sample because their small numbers did not provide reliable parameter estimates in the analyses.

Possible interactions of the training variables with two time trend variables were also included as independent variables in the regression analyses. The time variables were the day of field training (day variable) and week of graduation of the AOB class (week variable). Bessemer's (1991) results indicated that student performance improved on successive days of field training (day variable) and after the AOB instructors had more experience with using SIMNET (week variable). Since Bessemer (1991) found that the relationship between performance and day of training was curvilinear, both linear and quadratic components of trend for the day variable were used as independent variables. The week variable was counted from a zero reference point set at the week of 1 January 1988. The week variable was residualized (Draper & Smith, 1966) to obtain independent linear and quadratic trend components.

Preliminary analyses indicated that variance associated with instructor differences in rating bias had to be controlled in these equations. Substantial differences in the students' field ratings were found among groups with different team chiefs. Team chiefs were coded with ten dummy variables (0,1) to control this source of variance. Preliminary analyses also showed that a significant correlation $\underline{r} = .26$, $\underline{p} < .05$, existed between the students' evaluations for Rating 1 and Rating 2. Rating 1 was therefore used as a covariate in the analysis of Rating 2 data in order to form residual gains (such gain scores are discussed by Hiller, Fisher, & Kaess, 1968 as cited by Kerlinger & Pedhazur, 1973; Cohen & Cohen, 1983). Adjusted for Rating 1, the residual gains served as the effective dependent variable in the Rating 2 regression analysis.

The team chief variables were entered into the regression equation first in both analyses. The scores for Rating 1 were then entered as a covariate in the Rating 2 analysis. At the next stage in the analyses the SIMNET training, position sequence in field exercises, and time trend variables were entered together as a group, and variables were then retained in the equations by backward selection with $\alpha = .10$. The possible first order interactions among independent variables were then explored by forward selection with $\alpha = .05$.

In summary, the independent variables for the regression analyses were: (a) platoon leader or sergeant in SIMNET: (b) tank commander in SIMNET, (c) leader vs. sergeant in SIMNET, (d) position sequence in evaluated field exercises, (e) linear and quadratic polynomials for the day variable, (f) linear and quadratic components for the week variable, and (g) first order interactions among independent variables. Team chiefs differences were controlled in analyses of both Rating 1 and Rating 2. The Rating 2 analysis also included as a covariate the scores for Rating 1.

Results

Analysis of the Rating 1 data resulted in a significant regression model, $F(14, 455) = 6.97$, $p = .0000$, with team chiefs and four independent variables accounting for a modest portion ($R^2 = .177$) of the total variance among the students. The team chief differences alone were responsible for $R^2 = .141$, and the R^2 change (.036) associated with the independent variables was also significant. The tests are presented in the analysis of variance for Rating 1, at Appendix B, Table B-1.

The four independent variables retained in the Rating 1 regression equation were: (a) the SIMNET platoon leader or platoon sergeant variable, (b) field position sequence interaction with the preceding variable, (c) field position sequence interaction with the SIMNET tank commander variable, (d) the linear trend for week of AOB graduation. The three training variables (a, b, c) were jointly significant, $F(3, 455) = 3.08$, $p = .0272$, but tests for the individual regression coefficients presented in Table 2 were not significant with $\alpha = .05$.

Rating 1 adjusted means as a function of the student roles during SIMNET training are shown in Figure 1, along with 95% tolerance intervals indicating the probable range of sampling variation associated with each estimated mean. Comparisons between pairs of adjusted estimated means produced only one significant difference. Acting in a platoon leadership role (leader or sergeant) during SIMNET training as compared to acting as a tank commander in SIMNET led to significantly higher initial ratings for those students who were evaluated as platoon leaders in the field, $t(220) = 2.728$, $p = .0068$. The mean difference between these SIMNET role groups was not significant for students evaluated as platoon sergeants $t(218) = 0.672$, $p = .5022$. The small numbers of students that were in other crewman positions in SIMNET and the high sampling variability for their estimated means made the estimated differences of these groups with the leader or sergeant groups and with the tank commander groups very unreliable. Whether evaluated in the field as platoon leaders or as platoon sergeants, comparisons between the other crewman groups and the four remaining groups were all nonsignificant.

Among students with platoon leader field evaluations, the higher mean ratings obtained for students with platoon leadership

Table 2

Coefficients and Test Statistics for Independent Variables Retained in the Regression Models

Variable	β	SE_{β}	t[1]	p
		Rating 1 Analysis		
Platoon Leader or Platoon Sergeant	.0754	.0429	1.757	.0796
Position Sequence by Plt Ldr or Sgt	-.0732	.0431	-1.697	.0903
Position Sequence by Tank Commander	.0760	.0432	1.761	.0789
Week Linear Trend	.1601	.0504	3.176	.0016
		Rating 2 Analysis		
Position Sequence by Plt Ldr or Sgt	.0956	.0432	2.215	.0273
Day Linear Trend	.0900	.0452	1.990	.0472
Week Linear Trend	.0965	.0514	1.878	.0610
Rating 1	.1667	.0468	3.585	.0004

[1]Degrees of freedom = 455 for each test.

experience compared to those with tank commander experience is indicative of some specific transfer from their practiced role in SIMNET to their observed field performance as platoon leaders. The absence of a similar effect for students evaluated as platoon sergeants--and the lack of a significant difference between SIMNET platoon leaders compared to platoon sergeants among these same students--reflects the fact that the SIMNET training did not permit practice of specific platoon sergeant tasks that were performed and evaluated in the field. The students, for example, could not supervise their platoons' normal precombat equipment checks before SIMNET exercises. Thus, SIMNET limited the opportunity for specific learning transferable to field performance as a platoon sergeant.

Analysis of the Rating 2 data also produced a significant regression model, $F(14, 455) = 7.109$, $p = .0000$, with a total proportion of predicted variance $R^2 = .179$. In this case, the team chief differences alone accounted for $R^2 = .159$, and the R^2 changes from adding the Rating 1 covariate (.024) and three

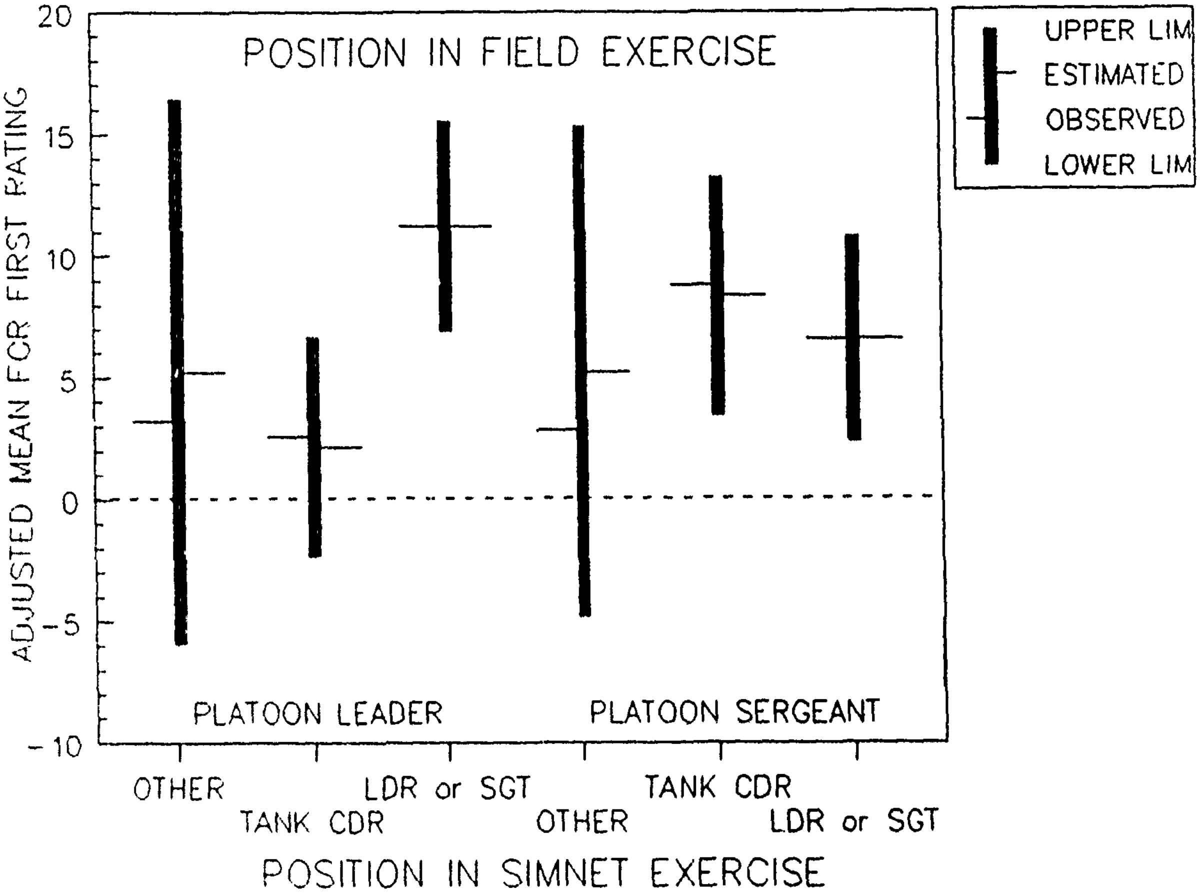

Figure 1. Effects of AOB students' SIMNET and field exercise positions on Rating 1 evaluations of field performance. Vertical bars are 95% tolerance intervals for the expected means.

independent variables (.020) were both significant. The analysis of variance for Rating 2 is shown in Appendix B, Table B-2.

The three independent variables retained in the Rating 2 regression equation were: (a) the interaction of field position sequence with the SIMNET platoon leader or sergeant variable, (b) the linear trend for day of field training, and (c) the linear trend for week of AOB graduation. The individual regression coefficients shown in Table _ were significant with α = .05 for the position interaction and day variables (a, b) but not for the week variable.

Figure 2 shows the Rating 2 adjusted means for groups of students with different roles in SIMNET training. These means were reconstituted by adding the overall Rating 2 mean (12.456) to the residual gains. The significant position sequence interaction with the SIMNET role resulted from one difference in ratings found between students evaluated as platoon leaders compared to those evaluated as platoon sergeants in the field. This difference was significant only for those students with platoon leadership (leader or sergeant) roles in SIMNET. No

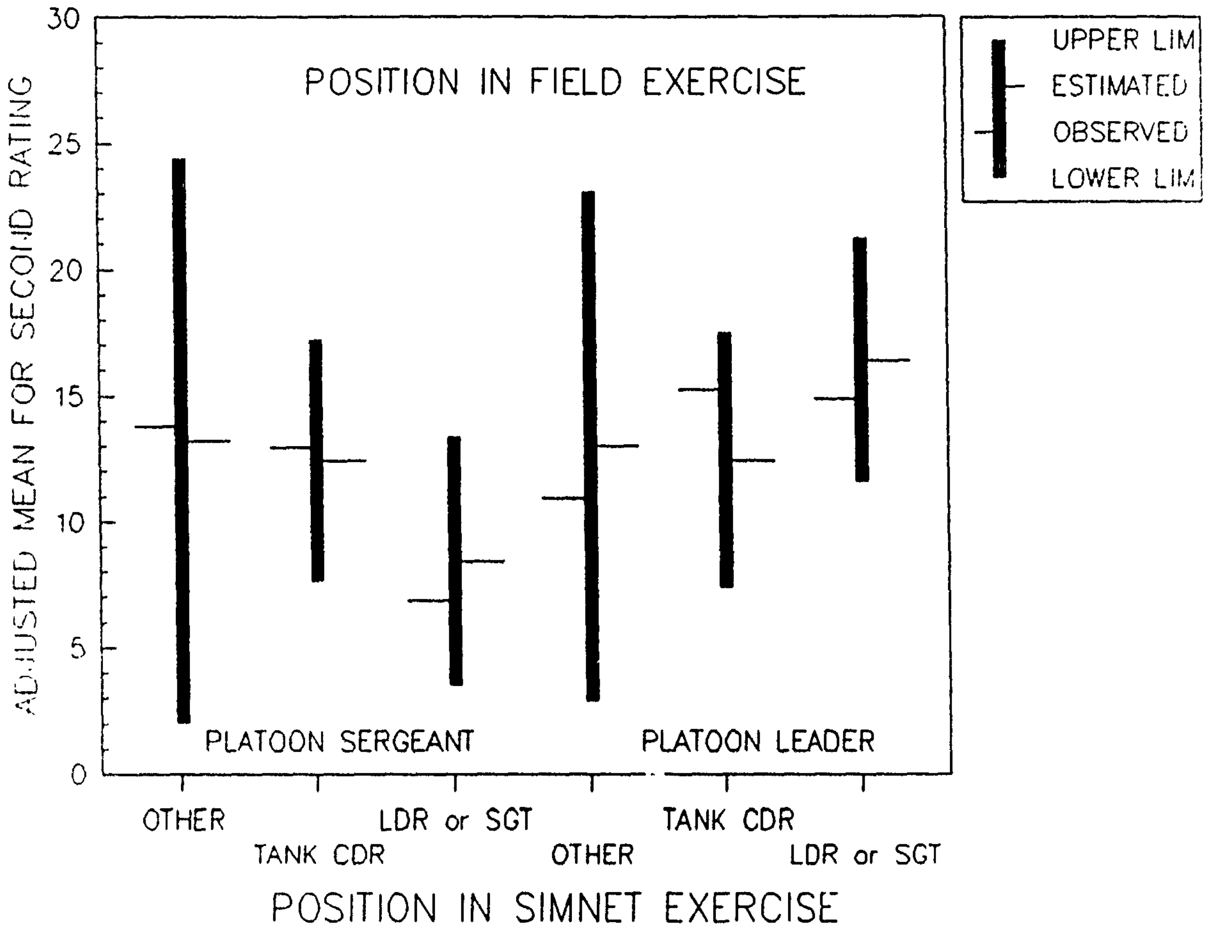

Figure 2. Effects of AOB students' SIMNET and field exercise positions on Rating 2 evaluations of field performance. Vertical bars are 95% tolerance intervals for the expected means.

other comparisons among these six groups were significant. The field evaluation positions in Figure 2 are reversed from those in Figure 1 because of the position sequence. In terms of their field position, student groups labeled platoon sergeants in Figure 2 are the same groups who were platoon leaders in Figure 1, and those groups labeled platoon leaders in Figure 2 were platoon sergeants in Figure 1.

In terms of residual gains, the significant effect of position in Figure 2 indicates that students who had a leadership role in SIMNET and were then evaluated in the field as platoon leaders performed better than predicted from their previous rating as a platoon sergeant, while those evaluated in the field as platoon sergeants performed less well than predicted from their previous rating as a platoon leader. Since those rated first as platoon sergeants had ratings around the average level, average performance evaluations would also be expected for their second ratings. Therefore, their higher than predicted Rating 2 values for their performance as platoon leaders reflects positive transfer of SIMNET training to platoon leader performance, similar to the effect found on Rating 1. This result shows that the specific benefit of SIMNET leadership training was durable enough to persist through the initial field exercises to affect Rating 2. On the other hand, those rated first as platoon leaders had above average first ratings that tended to increase the performance values expected for their second ratings. Thus, their lower Rating 2 values again reflect the lack of practice available in SIMNET for platoon sergeant tasks, resulting in performance evaluations that fell below expectation.

The positive coefficient for the day variable in Table 2 (and the lack of significant interaction terms involving this variable) indicates that performance in the field exercises was improving from day to day for both platoon leaders and platoon sergeants. This increase must be attributed to the students' observational learning rather than direct practice, since before their second evaluation, all students had served and had been evaluated in a leadership position in just one field exercise. Students were able to learn from the example of their peers, and the AARs after previous exercises. The absence of a similar increase from day to day in the Rating 1 data is related to the fact that the difficulty of the exercises is increasing during the first few days of training when most of the first ratings are obtained. The overall learning curve across days is flat for several days before increasing (see Bessemer, 1991).

The regression analyses for both Rating 1 and Rating 2 showed that the trend over time for the different AOB classes contributed to the partial regression equations. As shown in Figures 3 and 4, a linearly increasing slope was found for the trend in student evaluations across successive AOB classes as the weeks passed after the introduction of SIMNET training. These effects merely reconfirm Bessemer's (1991) results showing that the benefits of SIMNET increase as the AOB instructors gain experience with using this simulation.

For Rating 2, the trend effect was reduced by statistical adjustment based on the Rating 1 covariate. In the Rating 2 the effect of weeks is the partial linear trend in residual gains that remains after removing a portion of the trend that was associated with the Rating 1 covariate. Thus, the week effect estimated for residual gains is a trend <u>added</u> to the Rating 1 trend. Since the regression coefficient in Table 2 is positive, the estimated trend for the unadjusted Rating 2 data is actually greater than the estimated trend for Rating 1. The significance test shown in Table 2 simply requires the hypothesis $\beta = 0$ to be retained, indicating that the week trend observed for Rating 2 was not reliably larger than the trend for Rating 1. This result shows that the Rating 1 trend over weeks was fully maintained in the Rating 2 evaluation.

The effects of SIMNET training on these trends were a particular point of interest in the regression analyses. No significant interactions between SIMNET training variables and

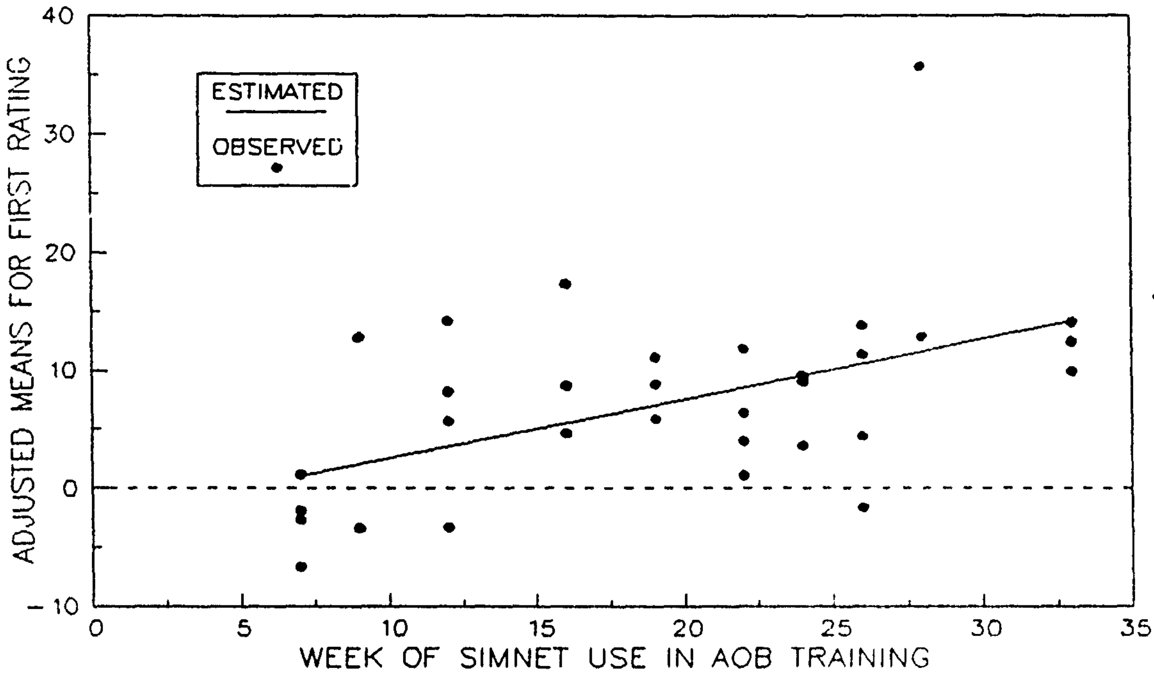

Figure 3. Trend for Rating 1 evaluations of field exercise performance across AOB classes. Each point represents the mean for one student platoon.

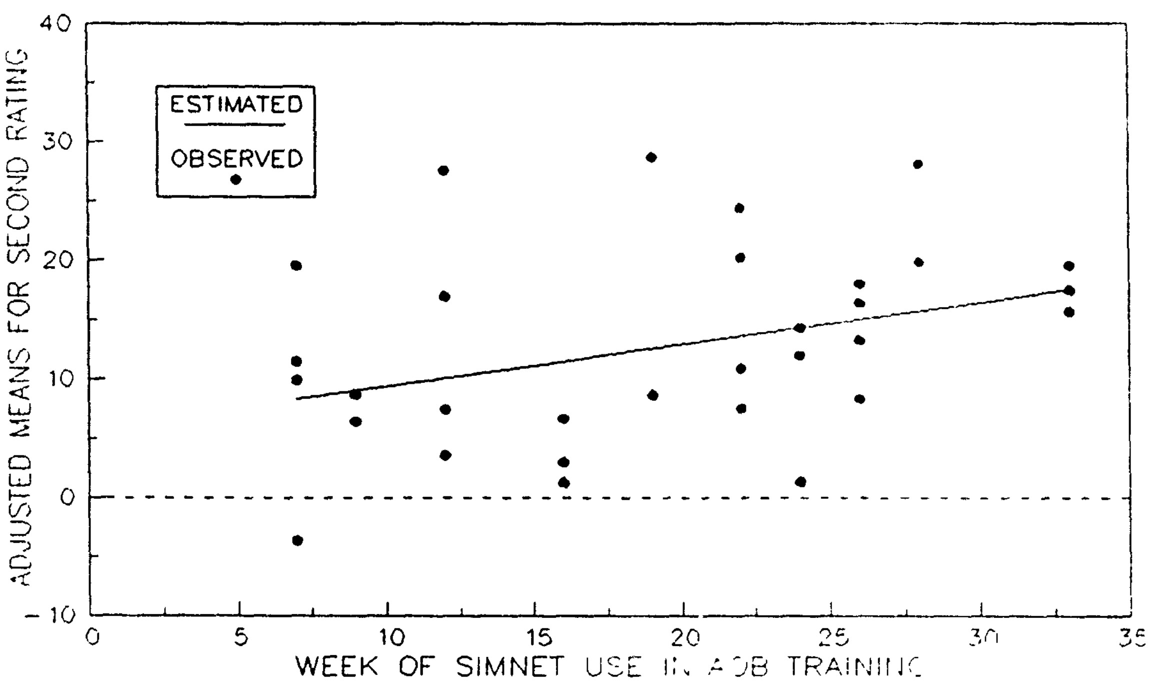

Figure 4. Trend for Rating 2 evaluations of field exercise performance across AOB classes. Each point represents the mean for one student platoon.

the linear trend over weeks were found either for Rating 1 or for Rating 2. Therefore, no evidence was obtained to suggest that the trends in Figures 3 and 4 were different for students with different SIMNET roles. Regression coefficients, partial correlations, and tests for such effects are presented in Appendix C, Table C-1.

Discussion

The results of this investigation indicate that SIMNET training was most effective when the students served in platoon leadership positions. AOB students learned more about being a platoon leader from doing platoon leader tasks themselves than they did from watching and hearing about the proper or improper actions of others. This learning from role-playing was later evident in improved performance when the students acted as platoon leaders in field exercises, according to the judgements of their instructors. This positive transfer of training effect occurred despite (a) the elaborate feedback regarding the SIMNET platoon leader's performance given to all students, (b) minimal role-playing opportunities provided to the AOB students during the SIMNET exercises, and (c) a strong central tendency bias on the evaluation scale.

The present findings affirm the value of direct active practice for cognitive training that has been hypothesized by Reigelith and Schwartz (1989) and others. However, the design of this study does not allow the position-specific training effects to be attributed entirely or even predominately to practice within the simulator. The SIMNET training provided to the students in platoon leader or platoon sergeant roles was a composite of (a) mission planning and troop-leading procedures, (b) platoon command, control, and communication during the SIMNET exercise, and (c) presentation of plans, recall of exercise events, and discussion in the AAR. Any or all of these experiences may have contributed to the transfer of training measured by the instructor's ratings.

The results do give one possible clue to the source of the training effect. The students assigned to the two leadership positions prepared their SIMNET mission plan cooperatively but performed different tasks in their roles during the exercise. Furthermore, the student platoon leader was asked to describe the plan and to narrate events in the AAR, while the student platoon sergeant participated only when called on for additional information. Despite the students' different experiences in the exercise and AAR phases, the finding that the SIMNET training was equally beneficial in promoting transfer for students in both roles suggests that mission planning could have been the most helpful part of the training.

Of course, alternative explanations may be postulated for the role-playing effects that were obtained. These effects might have been an artifact derived from confounded instructor, class, selection, or instrumentation effects. The regression analyses help to reduce this possibility by adjusting statistically for differences associated with the instructors and the trend across classes, but statistical adjustment does not fully substitute for experimental control. For those student background factors that were measured, the effects of a selection bias did not appear to pose a serious threat to this study's internal validity. On the other hand, other unmeasured variables may have been unequal between the groups with different SIMNET training, and have contributed to the observed performance differences. Although a standardized evaluation instrument was used to evaluate each student's field performance, the items available in this instrument may not be representative of aspects of platoon leadership that could be more easily learned though observation instead of role-playing. While the questions raised by such possibilities cannot be resolved in this investigation, they must be considered in designing future research on SIMNET training.

Without more detailed information on the parts of the SIMNET training that are most beneficial, instructor's techniques that are most helpful to student learning, and measures of training and tranfer for more specific aspects of performance, the present results offer little basis for recommending changes to the current training procedures. While active practice in the form of role-playing appears to be an important instructional variable affecting cognitive training, the necessary conditions for efficient and effective role-playing in tactical simulators remain to be determined.

Future research is then needed to determine feasible and effective strategies for implementing role-playing activities for all students during SIMNET training in school courses. One direct solution is simply to increase the training time and number of exercises in SIMNET. However, alternatives that make more intensive use of the time available may be needed when training time cannot be added. Some techniques may be most feasible in only one type of exercise, and unique methods may need to be invented for each context in different courses. The need for role-playing in SIMNET might be met for AOB students in part by having more platoon members serve as either a platoon leader or sergeant in different phases of each exercise. For example, in the AOB course, several pairs of students could act as platoon leader and sergeant during a road march. All pairs could be required to plan a segment of the mission. Each pair would give orders for their segment, and then take over command at a specific checkpoint to execute the segment. In other types of missions, a platoon leader or sergeant can be arbitrarily declared to be a casualty, requiring his subordinate to take over responsibility.

The regression analyses also shed some additional light on the increasing performance trend over weeks that Bessemer (1991) attributed to increased instructor experience. Assuming that the instructors improved their training within the SIMNET exercises, e.g., by better methods of exercise control or direct feedback to the student leaders, then the observed increase could be expected to be confined mainly to students with experience in the platoon leadership positions. These students were in positions that were most directly affected by the instructor's communications and actions during the exercise. A position-specific increase of this kind would result in an interaction effect between SIMNET role and the linear trend, but no such effect was found. In contrast, the present results showed that the trend over weeks and classes was a general effect, independent of the students' positions in SIMNET training. This finding leads to an alternate hypothesis: that the source of the gradually improved training was more likely to be associated with the AARs. Since all students participated in the AARs, improvement by the instructors in this part of training could benefit all students. This hypothesis is consistent with Bessemer's (1991) informal observations that indicated that the instructors conducted better AARs in later classes. Further research should be designed to more clearly identify what the instructors learn about SIMNET training or the AARs after conducting SIMNET exercises that helps them to increase transfer to the field exercises.

In closing, this study's findings and Bessemer (1991) have shown that the effectiveness of high-tech training simulators may depend on the instructional strategies used and the instructors' experience with the simulator. Having the students engage in active practice and having experienced instructors would appear to make training simulators more effective. Future research is needed to verify the generalizability of this claim. Future research should also focus on examining those instructional variables which make simulator training more effective in addition to the current emphasis on simulation fidelity and other aspects of the simulation technology.

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Appendix A

Frequencies and Residuals for Log-Linear Models of Personal Characteristic Distributions

Table A-1

Distributions of Responses and Missing Responses by AOB Students

Response and SIMNET Role	Observed Number	Expected Number	Residual	Adjusted Residual
	Citizenship			
Nonmissing				
Other Crewman	38.00	37.84	.162	.420
Tank Commander	193.00	193.17	-.174	-.251
Platoon Sergeant	115.00	114.51	.489	.807
Platoon Leader	122.00	122.48	-.477	-.768
Missing				
Other Crewman	0.00	0.16	-.162	-.420
Tank Commander	1.00	0.83	.174	.251
Platoon Sergeant	0.00	0.49	-.489	-.807
Platoon Leader	1.00	0.52	.477	.768
	Prior Service			
Nonmissing				
Other Crewman	27.00	25.95	1.047	.381
Tank Commander	123.00	132.50	-9.498	-1.912
Platoon Sergeant	76.00	78.54	-2.543	-.586
Platoon Leader	95.00	84.01	10.994	2.479
Missing				
Other Crewman	11.00	12.05	-1.047	-.381
Tank Commander	71.00	61.50	9.498	1.912
Platoon Sergeant	39.00	36.46	2.543	.586
Platoon Leader	28.00	38.99	-10.994	-2.479
	Source o. Commission			
Nonmissing				
Other Crewman	36.00	37.27	-1.272	-1.571
Tank Commander	189.00	190.29	-1.285	-.879
Platoon Sergeant	114.00	112.80	1.202	.941
Platoon Leader	122.00	120.64	1.355	1.038
Missing				
Other Crewman	2.00	0.73	1.272	1.571
Tank Commander	5.00	3.71	1.285	.879
Platoon Sergeant	1.00	2.20	-1.202	-.941
Platoon Leader	1.00	2.36	-1.355	-1.038

Note. Adj. Res. = Res. ÷ (Exp. No. × Variance[Res.])$^{1/2}$

Table A-2

Response Distributions for Citizenship of AOB Students with Missing Responses Omitted

Response and SIMNET Role	Observed Number	Expected Number	Residual	Adjusted Residual
United States				
Other Crewman	32.00	36.86	-4.863	-4.831
Tank Commander	186.00	187.23	-1.226	-.676
Platoon Sergeant	114.00	111.56	2.440	1.538
Platoon Leader	122.00	118.35	3.650	2.256
Foreign				
Other Crewman	6.00	1.14	4.863	4.831
Tank Commander	7.00	5.77	1.226	.676
Platoon Sergeant	1.00	3.44	-2.440	-1.538
Platoon Leader	.00	3.65	-3.650	-2.256

Note. Adj. Res. = Res. ÷ (Exp. No. × Variance[Res.])$^{1/2}$

Table A-3

Response Distributions for Prior Service of AOB Students with Missing Responses Omitted

Response and SIMNET Role	Observed Number	Expected Number	Residual	Adjusted Residual
None				
Other Crewman	12.00	11.86	.140	.057
Tank Commander	51.00	54.03	-3.028	-.700
Platoon Sergeant	39.00	33.38	5.617	1.486
Platoon Leader	39.00	41.73	-2.729	-.672
Active				
Other Crewman	7.00	3.03	3.972	2.531
Tank Commander	11.00	13.79	-2.794	-1.017
Platoon Sergeant	9.00	8.52	.477	.198
Platoon Leader	9.00	10.65	-1.654	-.641
Reserve				
Other Crewman	4.00	4.21	-.206	-.114
Tank Commander	20.00	19.16	.841	.266
Platoon Sergeant	8.00	11.84	-3.838	-1.390
Platoon Leader	18.00	14.80	3.202	1.080

(table continues)

Response and SIMNET Role	Observed Number	Expected Number	Residual	Adjusted Residual
Undefined[1]				
Other Crewman	4.00	7.91	-3.907	-1.726
Tank Commander	41.00	36.02	4.981	1.257
Platoon Sergeant	20.00	22.26	-2.255	-.651
Platoon Leader	29.00	27.82	1.181	.317

Note. Adj. Res. = Res. ÷ (Exp. No. × Variance[Res.])$^{1/2}$
[1]Response indicated some prior service, but type of service was omitted or ambiguous.

Table A-4

Response Distributions for Source of Commission of AOB Students with Missing Responses Omitted

Response and SIMNET Role	Observed Number	Expected Number	Residual	Adjusted Residual
Academy[1]				
Other Crewman	3.00	0.94	2.063	2.249
Tank Commander	4.00	4.92	-.920	-.547
Platoon Sergeant	1.00	2.97	-1.967	-1.334
Platoon Leader	4.00	3.18	.824	.547
ROTC[2]				
Other Crewman	26.00	29.52	-3.518	-1.590
Tank Commander	158.00	154.97	3.028	.746
Platoon Sergeant	101.00	93.48	7.525	2.114
Platoon Leader	93.00	100.03	-7.035	-1.933
OCS[3]				
Other Crewman	6.00	4.92	1.080	.546
Tank Commander	22.00	25.83	-3.829	-1.056
Platoon Sergeant	11.00	15.58	-4.579	-1.439
Platoon Leader	24.00	16.67	7.328	2.252
Other[4]				
Other Crewman	1.00	0.62	.375	.499
Tank Commander	5.00	3.28	1.720	1.247
Platoon Sergeant	1.00	1.98	-.978	-.809
Platoon Leader	1.00	2.12	-1.117	-.903

Note. Adj. Res. = Res. ÷ (Exp. No. × Variance[Res.])$^{1/2}$
[1]Graduates of U.S. military colleges are included. [2]Reserve Officer Training Corps. [3]Officer Candidate School. [4]Response was unclear or ambiguous.

Appendix B

Analysis of Variance Tables

Table B-1

Regression Analysis on Field Rating 1 Data

Source of Variance	df	Sum of Squares	Mean Square	F	p
Regression	4	11311.104	2827.777	4.968	.0006
Team Chiefs	10	44257.323	4425.732	7.515	.0000
Residual	455	258983.200	569.194		
Total	469	314551.627			

Table B-2

Regression Analysis on Field Rating 2 Data

Source of Variance	df	Sum of Squares	Mean Square	F	p
Regression	3	8329.439	2776.479	3.737	.0113
Rating 1	1	9800.773	9800.772	12.960	.0004
Team Chiefs	10	55810.301	5581.030	7.193	.0000
Residual	455	411955.562	742.890		
Total	469	485896.075			

Appendix C

Statistics for Trend Interactions

Table C-1

Coefficients and Test Statistics For the Interactions of SIMNET Role Variables with the Trend over Weeks

SIMNET Role	β	$r_{1.23}$	t[1]	p
		Rating 1 Analysis		
Platoon Leader vs. Platoon Sergeant	-.0316	-.0344	-0.734	.4634
Platoon Leader or Platoon Sergeant	-.0446	-.0327	-0.697	.4864
Tank Commander	.0508	.0427	0.910	.3634
		Rating 2 Analysis		
Platoon Leader vs. Platoon Sergeant	-.0455	-.0497	-1.060	.2899
Platoon Leader or Platoon Sergeant	.0515	.0400	0.854	.3945
Tank Commander	-.0529	-.0463	-0.988	.3238

[1]Degrees of freedom = 454 for each test.